

US EPA ARCHIVE DOCUMENT



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Kenneth Humphreys  
Chief Executive Officer  
217-243-8215

November 19, 2013

Rebecca Harvey  
Chief, Underground Injection Control Branch  
United States Environmental Protection Agency  
77 West Jackson Blvd  
Chicago, IL 60604-3590

**Subject: Request for Additional Information #1 Regarding, FutureGen Applications for UIC Permit nos. IL-137-6A-0001, -0002, -0003 & -0004, dated October 31, 2013**

Dear Ms. Harvey,

Please find enclosed one printed copy and one compact disc with an electronic copy of the FutureGen Alliance's responses to your Request for Additional Information (RAI #1) on the FutureGen Alliance's UIC applications dated October 31, 2013.

Inquiries concerning the contents of the enclosure may be directed to Tyler Gilmore by telephone (509) 371-7171 or by email to [tyler.gilmore@pnnl.gov](mailto:tyler.gilmore@pnnl.gov).

Sincerely,

Mr. Kenneth Humphreys  
Chief Executive Office  
FutureGen Industrial Alliance, Inc.

10-31-2013: Letter from Rebecca Harvey (EPA) to Kenneth K. Humphreys (Alliance), "Request for Additional Information Regarding four FutureGen 2.0 Wells, United States Environmental Protection Agency Underground Injection Control (UIC) Permit Applications for Four Geologic Sequestration Wells; United States Environmental Protection Agency UIC Permit Nos. IL-137-6A-0001, -0002, -0003, & -0004							
RAI #	Subject	Page	Doc. Sec.	Par.	EPA Comment / Question / Request	FutureGen Response	Footnote / Reference Citation
10-31-2013_001	Seismic Reflection Survey  &  Vertical Seismic Profiling Data	2.26	2.3.1.1	1	<p>"The Illinois State Geological Survey (ISGS) recently acquired a new 120-mi long seismic reflection survey across central Illinois as part of a DOE-sponsored research project to characterize reservoir rocks for geologic storage of carbon dioxide. The continuous east-west line extends from Meredosia to southwestern Champaign County (Figure 2.14). This line, which is currently under re-processing, will supply additional information about the structure of the sedimentary layers which will be correlated to the observations made on both profiles L101 and L201."</p> <p>"Future efforts at Morgan County will also include the acquisition of vertical seismic profiling data in the stratigraphic well to better evaluate the cause of the vertical disruptions in seismic reflections observed on the two existing seismic profiles."</p> <p><b>EPA: Have these tests been completed? Please report the results.</b></p>	<p>A discussion regarding these specific requests is presented in <a href="#">Appendix A</a>. A summary of the response is as follows:</p> <p>(1) The current processed Knox line was reviewed by Dr. John McBride, Brigham Young University, and formerly of the ISGS. Dr. McBride is an expert in Illinois seismic data. Dr. McBride's conclusion on the ISGS Knox line west of Ashland, Illinois, which is directly north of the proposed FutureGen storage site, is that there is no discernible faulting west of Ashland.<sup>1</sup> Dr. McBride also suggested that current plans to reprocess the ISGS Knox line would not likely result in a greatly improved image.<sup>2</sup> As a result, the technical team has cancelled plans to reprocess the ISGS Knox Line.</p> <p>Dr. McBride's interpretation of flat-lying, sedimentary layers with no major faults on the ISGS Knox Line west of Ashland correlates well with the technical team's interpretation of similar conditions on the Morgan County two-dimensional (2D) profiles L101 and L201.</p> <p>(2) A three-component vertical seismic profiling (VSP) data set was acquired from the FutureGen stratigraphic well in March 2013 and processed by Schlumberger Carbon Services. Dr. Bob Hardage of the University of Texas concluded<sup>3</sup> that no faults are present in the 15 2D seismic lines formed by the 15 offset VSP locations. These lines represent a lateral interrogation extent of 800–1600 feet radially from the stratigraphic well. The VSP data also do not contain the disruptions observed in the two original 2D seismic profiles (L101 and L201) of the proposed storage site.</p> <p>A second opinion evaluation of the vertical disruptions in the 2D Lines L101 and L201 was undertaken by Dr. John McBride, who concluded<sup>1</sup> that although the presence of small throw faults cannot completely be ruled out, the seismic anomalies in the 2D lines are most likely related to incompletely removed surface static noise, or due to the application of suboptimal filters during processing.</p>	<p><sup>1</sup>Phone Conference of Battelle Technical Team with John McBride, September 16, 2013.</p> <p><sup>2</sup>John McBride. Personal Communication with Charlotte Sullivan, October 29, 2013.</p> <p><sup>3</sup>Bob Hardage, Personal Communication with Charlotte Sullivan, August 1, 2013.</p>

10-31-2013: Letter from Rebecca Harvey (EPA) to Kenneth K. Humphreys (Alliance), "Request for Additional Information Regarding four FutureGen 2.0 Wells, United States Environmental Protection Agency Underground Injection Control (UIC) Permit Applications for Four Geologic Sequestration Wells; United States Environmental Protection Agency UIC Permit Nos. IL-137-6A-0001, -0002, -0003, & -0004							
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10-31-2013_002	Mini-frac Tests Leak-off Tests	2.30	2.4	3	<p>"Various supportive geomechanical data were collected, but there are no available "mini-frac" or leak-off tests to directly measure fracture pressure in either the injection or confining zones. Mini-frac or leak-off data are required to definitively calculate site-specific fracture gradients, and to produce high-confidence failure plots, fault slip tendency estimates, and critical pore fluid pressure increase estimates. All of these tests will be realized in 2013 during the second phase of the project"</p> <p><b>EPA: Have these tests been completed? Please report the results.</b></p>	<p><b>(1) Geomechanical characterization testing is currently being conducted (November 2013) with first analysis results expected late December 2013 or early January 2014.</b></p> <p>Geomechanical testing of the reservoir and basement rock is currently being conducted in the FutureGen stratigraphic well (November 2013). Testing involves a combination of Hydraulic Fracturing (HF) tests and Hydraulic Tests on Preexisting Fractures (HTPFs) that will be conducted in the existing, open-borehole section of the FutureGen stratigraphic well, to determine the state-of-stress at depth. Given the present situation in which the stratigraphic well is cased down to the Mount Simon Formation, the hydraulic testing in the Eau Claire Formation is postponed until the drilling of the injection pilot well.</p> <p>The testing program is designed to provide a more comprehensive characterization of the variation in magnitude for the minimum principal stress within the Mount Simon sandstone, as well as the required knowledge for the stress gradient in the Precambrian basement. This level of geomechanical characterization within both rock formations is necessary for determining the maximum acceptable reservoir pressure during future CO<sub>2</sub> injections.</p> <p><b>(2) Additional Geomechanical Characterization Tests at the Injection well site (second quarter, 2014)</b></p> <p>Pending issuance of a Underground Injection Control (UIC) permit, an injection well will be drilled at the proposed injection site. Additional geomechanical tests (HF tests and/or HTPFs) will be conducted in this well in the primary confining zone and in the injection zone.</p>	
10-31-2013_003	Triaxial Core- Plug Tests	2.31	2.4.2	1	<p>"Uncalibrated geomechanical stress properties logs were calculated from the density log and the compressional and shear wave sonic log data. These geomechanical logs indicate there is strong stress anisotropy. These uncalibrated geomechanical logs will later have been calibrated over the cored interval with six triaxial core-plug tests."</p> <p><b>EPA: Has this analysis been completed? If so, please report the results.</b></p>	<p>The triaxial core-plug tests' results were provided to Schlumberger, who used them to calibrate the geomechanical log data. The original triaxial test data are provided in the Supporting Documentation for the Alliance's Class VI UIC permit applications (Tables 2.10 and 2.11). The resulting calibrated Schlumberger geomechanical logs still indicate strong anisotropy. However, only geomechanical field tests currently being conducted in the existing stratigraphic wellbore and planned in the Pilot Well will result in a quantification of the site stress regime.</p>	
10-31-2013_004	Horizontal Components of Stress	2.32	2.4.2.2	2	<p>"Data are insufficient at this stage of analysis to be able to quantify the horizontal components of stress and thus distinguish between normal and strike-slip regimes."</p> <p><b>EPA: How will you obtain and when will you have sufficient data?</b></p>	<p>The data from the on-going borehole geomechanical tests (November 2013) include a combination of HF tests and of HTPFs, which are very well suited for identifying stress fields at depth (Cornet 1993; Haimson and Cornet 2003). The results will provide the data necessary to quantify the horizontal components of stress and be able to distinguish between extensional, compressional, and strike-slip regimes. The results of this testing will be provided to the U.S. Environmental Protection Agency (EPA) soon after they have been analyzed, which is anticipated to be in late December 2013 or early January 2014..</p>	<p>Cornet F.H.; 1993; The HTPF and the Integrated stress determination methods; Comprehensive Rock Engineering (Hudson ed.); Vol 3, ch. 15, pp 413-432 Pergammon Press, Oxford.</p> <p>Haimson B.C. and F.H. Cornet; 2003; ISRM Suggested Methods for rock stress estimation; Part III:Hydraulic fracturing methods ; Int. Jou. Rock. Mech. Min. Sc., vol. 40, 7/8, pp 1011-1020.</p>
10-31-2013_005	New Knowledge About the Site	5.4	5.1.2	1	<p>"As additional characterization data are collected, the site conceptual model will be revised and the modeling steps described above will be updated to incorporate new knowledge about the site". i.e., they will add information to this section as it becomes available</p> <p><b>EPA: When will this be done?</b></p>	<p>The site conceptual model will be updated after key data collection efforts are completed or when new information becomes available that could substantially modify the conceptual model. This will be an on-going and iterative process over the life of the project. The next data collection effort, which may provide data that will update or modify the conceptual model, is the geomechanical testing in the stratigraphic well. Therefore, the next conceptual model update could occur following interpretation of the geomechanical data. We anticipate making that determination in early January 2014.</p>	

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10-31-2013_006	Indirect Monitoring Approaches	5.8	5.1.4	1	<p>"The location of any wells required to support implementation of indirect monitoring approaches <u>will be determined</u> once candidate technologies have been evaluated and the selection process completed." FutureGen has selected locations for the monitoring wells based on the preliminary modeling. Once they begin on-site activity, these locations may change. If the locations do change, the monitoring wells will retain the intent described in this plan.</p> <p><b>EPA: When will these technologies be evaluated and when will any changes be proposed?</b></p>	<p>The screening of the indirect monitoring approaches was conducted as part of the Front End Engineering Design process. The selected indirect technologies will include the following:</p> <ul style="list-style-type: none"> <li>pulsed neutron capture logging or determination of reservoir CO<sub>2</sub> saturation</li> <li>integrated deformation monitoring</li> <li>time-lapse gravity</li> <li>microseismic monitoring.</li> </ul> <p>In addition, a baseline VSP survey in at least one of the "Above Caprock Zone" (ACZ) wells will be conducted after construction of the monitoring well network and if the EPA provides approval of the UIC permit application.</p> <p>The monitoring well locations have been identified; however land owner agreements still need to be finalized. We anticipate that we will have the final agreements before the end of January, 2014 and can map the locations at that time.</p>	
10-31-2013_007	EPA Form 7520-14		6		<p>EPA Form 7520-14 (Plugging &amp; Abandonment Plan) is missing.</p> <p><b>EPA: Please provide for each well.</b></p>	EPA Form 7520-14 has been completed for open-hole and cased-hole completions with laterals of 1,500 ft and 2,500 ft (4 forms, in <a href="#">Appendix B</a> ). These forms were unintentionally missing in the UIC Permit Application and are being submitted with this response.	
10-31-2013_008	EverCrete Cement Information		6		<p>Information concerning the slurry volume and slurry weight of the EverCrete cement is needed</p>	<p>(1) The slurry volume (yield) is 1.12 ft<sup>3</sup>/sack.            (2) The slurry weight is 15.82 lb/gal.            (3) Lab analyses of the EverCRETE-5 cement blend and a technical report are also attached (<a href="#">Appendix C</a>).</p> <p>Note that the Alliance plans to use a Class H cement, and the product brand, EverCRETE-5, is an example of a class H cement.</p>	
10-31-2013_009	Casing & Retainer in Figure 6.2	6.5	6		<p>In <b>Figure 6.2</b>, the 7" casing is set at 3400 feet, however a cement retainer will be at 3900 feet, which is below the cased hole.</p> <p><b>EPA: Please correct.</b></p>	The carbon-steel casing will be run to a depth of 3,400 ft and stainless steel casing will be run from 3,400 ft to 3,950 ft. For clarity, an updated version of Figure 6.2 is attached in <a href="#">Appendix D</a> . For consistency, Figures 4.4, 4.5, and 6.1 have also been updated and are provided in <a href="#">Appendix D</a> .	



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10-31-2013_010	Financial Mechanisms	9.2	9		<p><b>Table 9.1. Approach to Meeting Financial Responsibility Requirements</b> – several financial mechanisms state that they are to be "Created prior to injection." <b>These must be established prior to drilling of the wells.</b></p> <p><b>EPA: Please provide the mechanism to EPA.</b></p>	<p>As described in Chapter 9.0 of the Supporting Documentation for the Alliance's Class VI UIC permit applications, the Alliance intends to establish a CO<sub>2</sub> Storage Trust Fund for the payment of costs related to any needed corrective actions as well as costs related to injection well plugging and post-injection site care and site closure. The Alliance intends to obtain third-party insurance for costs related to any required emergency and remedial response action.</p> <p>The Alliance has selected a trustee for the CO<sub>2</sub> Storage Trust Fund (U.S. Bank) and is actively working with the trustee to complete a trust agreement that includes the terms recommended by the EPA. The Alliance will expedite these efforts and provide a schedule for completion of the trust agreement to the EPA at the earliest possible time.</p> <p>With respect to third-party insurance, the Alliance is continuing to work with its insurance advisor to obtain the necessary insurance for the drilling, injection, and post-injection phases of the FutureGen 2.0 Project. During the drilling phase of the project, the potential to incur emergency and remedial response costs will be even less than the potential for such costs during the later injection and post-injection phases. For this reason, the Alliance is planning to purchase a pollution policy with a \$10 million limit for the drilling phase. This will contain coverage outlined in Appendix D to the Supporting Documentation (McGriff, Seibels &amp; Williams, Inc., "Insurance Review to Support FutureGen Alliance's UIC Permit Application," September 2012). Prior to injection, the Alliance will increase the limits of this policy to at least \$100 million. At that time, the Alliance will also purchase various other insurance policies including Control of Well and General Liability insurance and Umbrella/Excess coverage. The Alliance will provide updates to its insurance acquisition efforts as they become available.</p> <p>The Alliance recognizes that, in accordance with 40 CFR 146.85(a)(5)(i), the EPA must approve financial responsibility demonstrations for all phases of the geologic sequestration project prior to the issuance of a Class VI permit. To this end, the Alliance will provide such demonstrations at the earliest opportunity. The Alliance may wish to discuss with the EPA representatives the documentation considered necessary to demonstrate financial responsibility for each phase of the project.</p>	
10-31-2013_011	Endangered Species Act				<p>In accordance with 40 CFR 144.4 (c), the U. S. Environmental Protection Agency (EPA) is required to comply with the Endangered Species Act (ESA) when issuing permit decisions. Therefore, when considering a permit application, the Underground Injection Control (UIC) Branch must consider the potential impacts from the new or existing injection well to endangered species present in the area. In order to determine whether an injection well will adversely impact endangered and threatened species, the UIC branch must have location-specific ecological information, such as the presence of certain vegetation, soils or surface water bodies. The U. S. Fish and Wildlife Service has listed the following in Morgan County :</p>	<p>In siting the components of the FutureGen 2.0 Project, including the site for the four proposed injection wells, the Alliance has successfully avoided potential impacts on threatened or endangered species that are listed for Morgan County, Illinois (Indiana bat, decurrent false aster, and eastern prairie fringed orchid) and the critical habitats for these species. The U.S. Department of Energy (DOE) has also considered the potential impacts on these species, and other environmental resources, and documented its findings in its FutureGen 2.0 Environmental Impact Statement issued final in October 2013 (Final Environmental Impact Statement for the FutureGen 2.0 Project, <a href="http://www.netl.doe.gov/publications/others/nepa/feis_1013.html">http://www.netl.doe.gov/publications/others/nepa/feis_1013.html</a>) (The EPA rated the draft environmental impact statement as LO-1). With assistance from the Alliance, DOE submitted a Biological Assessment to the U.S. Fish and Wildlife Service (USFWS) in accordance with the Endangered Species Act that encompassed the entire project, power plant, pipeline, and injection wells. Recently, the USFWS concurred with DOE's conclusion that the FutureGen 2.0 Project as a whole, including the injection well site, could affect but is not likely to affect any of the threatened or endangered species in Morgan County. A copy of the USFWS letter is attached (<a href="#">Appendix E</a>).</p> <p>With respect to the EPA's specific requests:</p> <p>a. The area proposed for the injection wells has been determined by the USFWS (<a href="#">Appendix E</a>) to not contain any critical habitat for any threatened or endangered species..</p> <p>b. The 9.5 acres that are expected to be disturbed during the construction of the injection wells, including the approximately 5 acres that will contain the four proposed injection wells, are primarily plowed fields. A small portion includes an unoccupied dwelling, which will be removed. A few trees</p>	

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RAI #	Subject	Page	Doc. Sec.	Par.	EPA Comment / Question / Request				FutureGen Response	Footnote / Reference Citation
					<div>Morgan Field Office to Contact: U.S. Fish and Wildlife Service Marion Illinois Sub-Office 8588 Route 148 Marion, Illinois 62959 Phone: (618) 997-3344, ext. 340 FAX: (618) 997-8961 e:mail Marion@fws.gov</div>	<div>Indiana bat (Myotis sodalis)</div>	<div>Endangered</div>	<div>Caves, mines (hibernacula); small stream corridors with well developed riparian woods; upland forests (foraging)</div>	and bushes are used as landscaping near the dwelling. As noted above, and in the attached USFWS consultation letter, the area has not been designated as critical habitat for any threatened or endangered species, and there will be no cutting of trees, which could provide summer habitat for listed bat species.	
				<div></div>	<div>Decurrent false aster (Boltonia decurrens)</div>	<div>Threatened</div>	<div>Disturbed alluvial soils</div>			
				<div></div>	<div>Eastern prairie fringed orchid (Platanthera leucophaea)</div>	<div>Threatened</div>	<div>Mesic to wet prairies</div>			
					<p>As a result, we are requiring the following information to be submitted in each permit application.</p> <p>a. A summary of the critical habitat which, if present, may support one the above-listed species. Detailed information on critical habitat can be found at the following web address: <a href="http://www.fws.gov/midwest/endangered/section7/s7process/lifehistory.html">http://www.fws.gov/midwest/endangered/section7/s7process/lifehistory.html</a></p> <p>b. A survey of the surface vegetation, soils, topography and hydrologic features in the action area in sufficient detail to address the presence or absence of critical habitat for any endangered, threatened, or candidate species. This will include descriptions such as “mature mixed forest”, plowed field” or “stabilized dunes”, and may also include specific trees or plants listed as critical to a species.</p>					

# **Appendix A**

## **RAI# 10-31-2013\_001**

Additional Information Regarding  
Seismic Reflection Survey  
and  
Vertical Seismic Profiling Data



The following discussion addresses the specific request for additional information regarding 2D-seismic profiles and vertical seismic profiling data (RAI# 10-31-2013\_001).

We first present a review of the existing 2D seismic data, and a summary of the evaluation by outside seismic consultant, Dr. John McBride. Dr. McBride's review includes both the Morgan County 2D data and of the western end the ISGS Knox line, which runs east-west through Cass County, about three miles north of our Line L201. We then review the status of new VSP data acquisition and a summary of the interpretation of the VSP data by outside seismic consultant, Dr. Bob Hardage.

## 1. Introduction

Subsurface data relative to seismic characterization of the Morgan County site include the following:

- A total of fifteen miles of 2D-seismic data, acquired along line L101 and L201, processed and interpreted First Quarter, 2011; reprocessed Third Quarter, 2012.
- A suite of well logs, including density and dipole sonic (for construction of synthetic seismograms), acquired in the FutureGen2.0 characterization well, Fourth Quarter, 2011.
- 15 offset VSP's and a zero offset VSP, acquired in the characterization well, First Quarter, 2013.

Figure 1 shows the locations where these data were acquired, relative to the stratigraphic well and the proposed injection well.

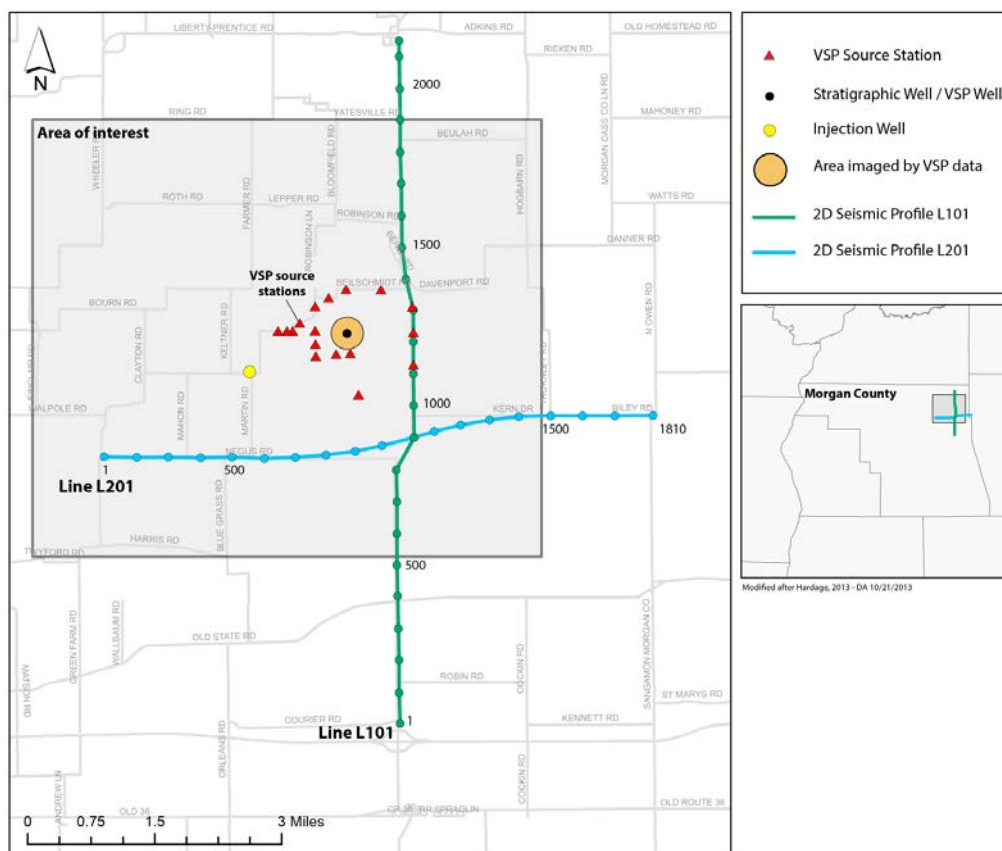


Figure 1. Location of Seismic Data Acquired for Characterization of the Morgan County Site.

## 2. Review of 2D-Seismic Profiles

### 2.1 FutureGen Site 2D Seismic Survey

Two orthogonal seismic lines were acquired and processed across the FutureGen 2.0 sequestration site in Morgan County, Illinois, during the period January to February, 2011. Surface seismic data were acquired as single-component data, so only P-P images have been made along Line 101 and Line 201 (Figure 1).

The original data exhibit vertical discontinuities with little to no offset, and a severe loss of frequency and resolution below a two-way time (TWT) depth of about 0.3 seconds (S), approximately coincident with the top of the Galena limestone at a depth of 1,400 feet. The original data were evaluated by Dr. Hardage<sup>1</sup>, who concluded that the discontinuities could be acquisition/processing artifacts or could be very small offset faults. In August, 2012, these lines were reprocessed by Exploration Development, Inc., and re-evaluated by Dr. Hardage<sup>2</sup>. Although the reprocessed data had less seismic noise, vertical discontinuities remained (Figure 2), especially at locations where the seismic lines crossed small streams.

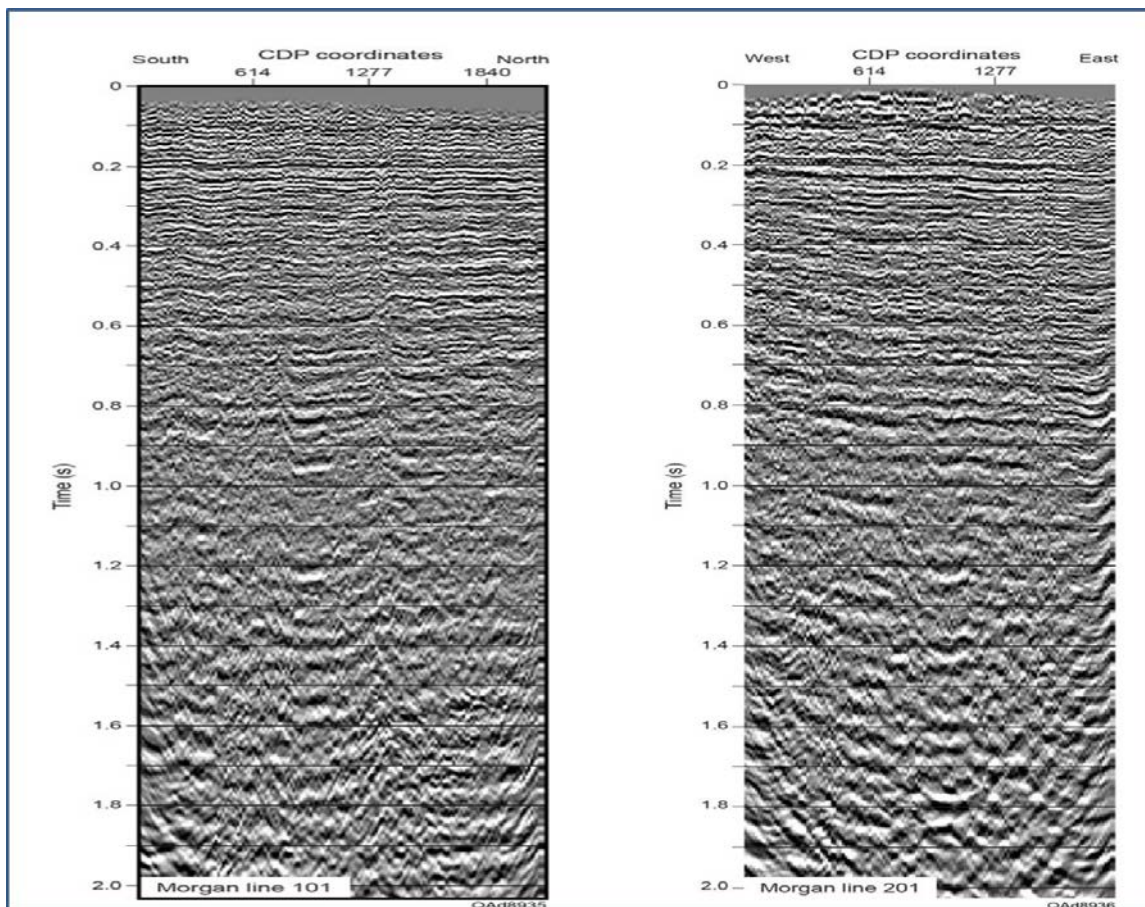
A second interpretation of the Morgan County 2D lines was provided by Dr. John McBride (geophysicist from Brigham Young University, formerly ISGS), *"There are no large scale features in the Morgan County site data that cut into the shallow section, however it cannot be definitively determined that there are no faults in the Morgan County data. Some anomalies coincide with streams; others may be related to binning issues. Better static corrections may be required in order to determine if offsets in the shallow (0-400 ms) section are actual small faults or are just distortions due to unaccounted-for lateral velocity changes (e.g., associated with small stream valleys)."*<sup>3</sup>.

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<sup>1</sup> Bob Hardage. Personal Communication with Charlotte Sullivan, March 7, 2011.

<sup>2</sup> Bob Hardage. Personal Communication with Charlotte Sullivan , January 22, 2013.

<sup>3</sup> Phone Conference of Battelle Technical Team with John McBride September 16, 2013.



**Figure 2. Reprocessed Morgan County P-P seismic data.** The data are presented in a gray-scale squash-plot format to emphasize vertical discontinuities. Line 101 is 8 miles long; Line 201 is approximately 7 miles long. The Mount Simon is at a two way time depth of about 0.6 seconds; Precambrian basement about 0.68S. Artifacts are especially pronounced at depth and on edges of images.

## 2.2 Knox Line 2D-Seismic Survey

The Illinois State Geological Survey (ISGS) acquired a 120-mile-long 2D seismic survey across central Illinois as part of a U.S. Department of Energy-sponsored research project. The line extends from Meredosia to southern Champaign County (Figure 3).

The ISGS Knox 2D-seismic line runs east-west, through Cass County, about 3 miles north of the FutureGen 2.0 CO<sub>2</sub> storage site. Dr. McBride reviewed the data that are closest to the FutureGen 2.0 site: *“There do not appear to be any obvious, indisputable large faults in the western part of the ISGS line [west of Ashland]; however, seismic interpretations shown by ISGS personnel along the western part of the regional Knox Line 101 [east of Ashland] indicate down-to-the-east normal faults that affect the Mt. Simon Sandstone, although not necessarily the Eau Claire Shale (base of Knox). For example, such a fault has been tentatively interpreted below about CDP 9000. This*

is located about 2.5 miles northwest of Pleasant Plains and almost 6 miles northeast of the northern end of Morgan Co. L101”<sup>4</sup>.

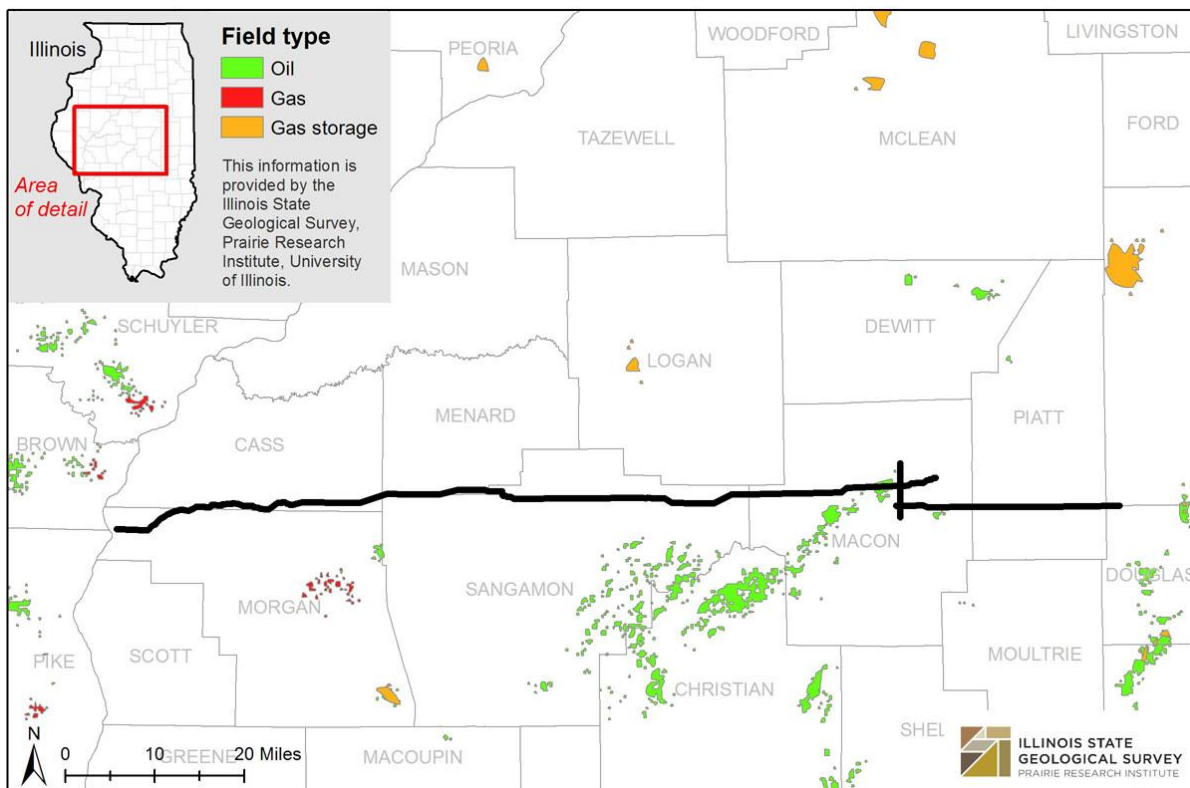


Figure 3. Location of the Knox seismic-reflection survey (ISGS, 2013)

### 3. Vertical Seismic profile (VSP)

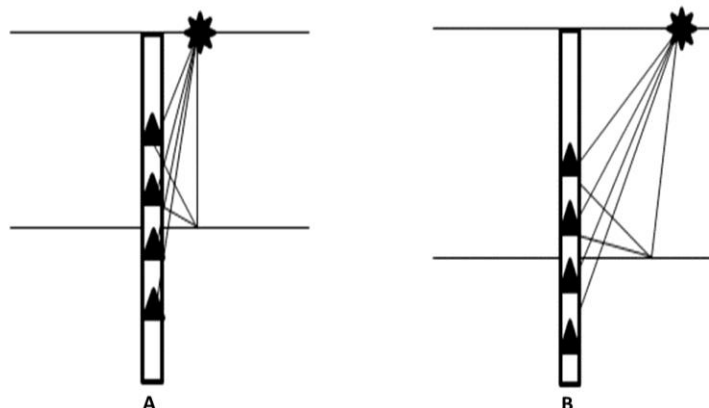
#### 3.1 Principle, objectives and data acquisition

Vertical seismic profile (VSP) surveys are conducted by activating seismic sources (vibrois trucks using vehicle-mounted vibrator plates, in the case of the 2013 FutureGen 2.0 survey) at the Earth’s surface and recording the seismic signals with an array of receivers that are placed in a borehole. The use of three component geophones at the Morgan County site allowed both reflected compressional wave and shear wave data to be captured.

If a single seismic energy source position is used within a few hundred feet of the borehole, the survey is referred to as being zero offset VSP ; at a longer seismic source-source distance, the borehole survey is an offset VSP (Figure 4).

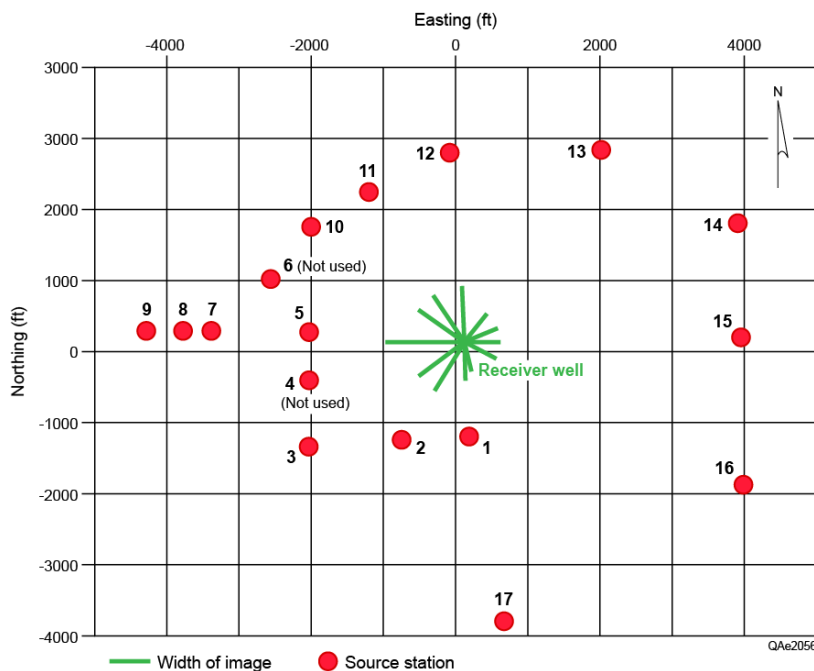
The fundamental objective of the Morgan County VSP program was to determine if visible faults cut the Mount Simon or Eau Claire in any of the 12 azimuths imaged by 15 offset VSP’s (Figure 5).

<sup>4</sup> John McBride. Personal Communication with Charlotte Sullivan, October 29, 2013.



**Figure 4. Schematic Drawings of a) Zero Offset and b) Offset VSP. The seismic source is at the Earth's surface; geophones are in the wellbore.**

The original VSP data-acquisition plan was to acquire data with 17 source stations encircling the FGA-1 stratigraphic well (Figure 5). Due to wet, thawed soil conditions in the fields, all source stations had to be positioned on local roads; and data were not acquired at source stations 4 and 6. The location and lateral widths of the 2D seismic images generated by each source station is indicated in Figure 5 by a spoke wheel pattern radiating away from the FGA-1 well. A separate P-P and P-SV (wave converted from P to S in the subsurface) seismic image was generated for the zero offset and for each offset VSP; the lateral length of each 2D image is listed in Table 1.



**Figure 5: Offset VSP Source Stations. The lateral lengths of good-quality VSP images (Table 1) are indicated by the lengths of the lines in the spoke wheel pattern centered on the FGA-1 well. Distance from the stratigraphic well to Station 15 is approximately 4000 ft.**



**Table 1. Lateral lengths of VSP P-P and P-SV Images across the Mt. Simon Interval.**

Source station	Width of P-P image (ft)	Width of P-SV image (ft)
1	550	300
2	800	500
3	800	700
4*	Not used	Not used
5	1100 combined (Source stations 5, 7, 8 and 9)	1100 combined (Source stations 5, 7, 8 and 9)
6*		
7		
8		
9		
10	800	700
11	800	700
12	800	550
13	500	550
14	500	650
15	500	650
16	500	600
17	400	400

\*Not used

QAe2056(a)

### 3.2 Data-interpretation

The resulting P-P and P-SV data were interpreted by Dr. Bob Hardage, who determined that no discontinuities of the type observed in 2D Line L101 or L201 are present in the VSP images<sup>5</sup> and that there is no evidence of faults in any of the images<sup>6</sup>. Dr. Hardage pointed out that the areas imaged by the short 2D lines generated by the VSP surveys still represent a small part of the site.

### 4. Summary

Neither the 2D-seismic profiles (Line L101 and L201) acquired at the FutureGen 2.0 site nor the Knox profile exhibit any large scale structural features near the Morgan County site.

Reprocessing of the ISGS Knox line was postponed until after evaluation of all 2D lines by Dr. John McBride, who is a specialist on Illinois seismic data and subsurface structure, and who is familiar with the different generations (original plus two reprocessed versions) of the Knox line data. Dr. McBride's conclusions are that there are no discernible faults in either the Knox line west of Ashville Illinois (about 5 miles NNE of the Morgan County site) or in the 15 miles of 2D data acquired along roads at the Morgan County site, although the presence of small-throw faults cannot be completely ruled out by 2D seismic data. As a result of Dr. McBride's interpretation, it was determined that reprocessing the Knox line will not provide additional information.

<sup>5</sup> Bob Hardage. Personal Communication with Charlotte Sullivan, October 18, 2013.

<sup>6</sup> Bob Hardage, Personal Communication with Charlotte Sullivan, August 1, 2013.



Discontinuities observed in the Morgan County 2D lines were not resolved by reprocessing the lines in 2012; two independent seismic specialists conclude that the remaining vertical discontinuities have a high probability of being artifacts due to acquisition and processing, specifically related to incomplete removal of surface seismic noise caused by offsets in acquisition lines ("crooked lines") and streams, by the choice of filters used during processing, and other processing parameters.

A zero offset VSP and 15 offset VSP's were acquired in March 2013 to better determine if faults or fracture zones are present at the site. The VSP images are good quality, and no vertical discontinuities were observed in any of the offsets. Interpretation by Dr. Bob Hardage<sup>7</sup> of the data indicates there is no evidence of faulting within the VSP image space.

## 5. Cited Reference

ISGS, 2013. "Seismic Line Data Release to Spur Additional Oil Exploration". <http://www.isgs.illinois.edu/?q=seismic-line-data-release-spur-additional-oil-exploration>. Last accessed on November 20, 2013.

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<sup>7</sup> Bob Hardage, Personal Communication with Charlotte Sullivan, August 1, 2013.

# Appendix B

## RAI# 10-31-2013\_007

Form 7520-14: Plugging and Abandonment Plan

for


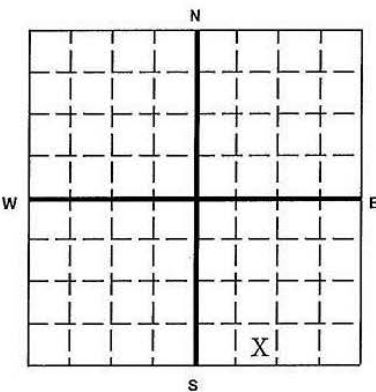
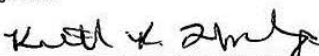
Cased Well Completion, 1,500 ft Lateral

Cased Well Completion, 2,500 ft Lateral

Uncased Well Completion, 1,500 ft Lateral

Uncased Well Completion, 2,500 ft Lateral


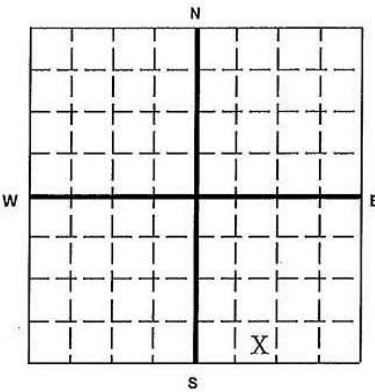
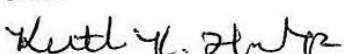
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<div style="display: flex; justify-content: space-between;"><div style="width: 40%;"><b>Name and Official Title (Please type or print)</b> Kenneth K. Humphreys, Chief Executive Officer</div><div style="width: 30%;"><b>Signature</b> </div><div style="width: 30%;"><b>Date Signed</b> 11/18/13</div></div>																																																																																		

EPA Form 7520-14 (Rev. 12-11)



OMB No. 2040-0042 Approval Expires 11/30/2014



United States Environmental Protection Agency  
Washington, DC 20460

## PLUGGING AND ABANDONMENT PLAN

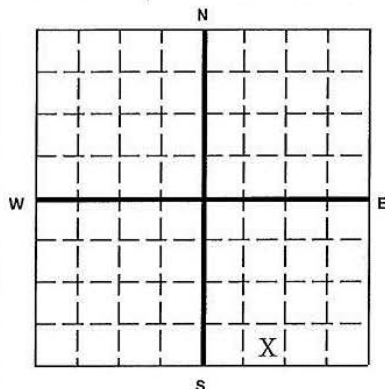
### Name and Address of Facility

Morgan County Class VI UIC Well  
(open well completion, 2,500 ft lateral) [address not yet available]

### Name and Address of Owner/Operator

FutureGen Alliance, Inc.  
73 Central Park Plaza East, Jacksonville, IL 62650

### Locate Well and Outline Unit on Section Plat - 640 Acres



State  
Illinois

County  
Morgan

Permit Number  
not yet issued

### Surface Location Description

SE 1/4 of SE 1/4 of SW 1/4 of SE 1/4 of Section 26 Township 16N Range 9W

Locate well in two directions from nearest lines of quarter section and drilling unit

### Surface

Location  ft. from (N/S)  Line of quarter section  
and  ft. from (E/W)  Line of quarter section.

### TYPE OF AUTHORIZATION

- ☒ Individual Permit  
☐ Area Permit  
☐ Rule

Number of Wells  1

### WELL ACTIVITY

- ☐ CLASS I  
☐ CLASS II  
☐ Brine Disposal  
☐ Enhanced Recovery  
☐ Hydrocarbon Storage  
☐ CLASS III

Lease Name

Well Number

### CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
24"	140.0	140'	140'	30"
16"	84.0	570'	570'	20"
10 3/4"	51.0	3,150'	3,150'	14 3/4"
7"	29.0	3,950	3,950	9 1/2"

### METHOD OF EMPLACEMENT OF CEMENT PLUGS

- ☒ The Balance Method  
☐ The Dump Bailer Method  
☐ The Two-Plug Method  
☐ Other

### CEMENTING TO PLUG AND ABANDON DATA:

	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inches)	7"	7"	7"	7"			
Depth to Bottom of Tubing or Drill Pipe (ft)	3,950	3,900	1,800	700			
Sacks of Cement To Be Used (each plug)	1,500	150	53	124			
Slurry Volume To Be Pumped (cu. ft.)	1,680	168	62.5	146.3			
Calculated Top of Plug (ft.)	3,900	3,100	1,500	0 (GL)			
Measured Top of Plug (if tagged ft.)	3,900	3,100	1,500	0 (GL)			
Slurry Wt. (Lb./Gal.)	15.82	15.82	15.6	15.6			
Type Cement or Other Material (Class III)	EverCrete	EverCrete	Class A	Class A			

### LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
(9 1/2" open hole) 3,950 ft MD	7,004 ft MD		

### Estimated Cost to Plug Wells

Plug #1 Set through a cement retainer set at 3,900 ft MD  
\$600,000.00

### Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title (Please type or print)

Kenneth K. Humphreys, Chief Executive Officer

Signature

Date Signed

11/18/13



# Appendix C

## RAI# 10-31-2013\_008

EverCrete Cement Information



## Laboratory Cement Test Report-CAR10-384 EverCRETE-5

Fluid No :	Client :	Location / Rig :	Signatures
Date : Oct-17-2010	Well Name :	Field : Wildcat	Mark Meade

Job Type	Production	Depth	7200.0 ft	TVD	7200.0 ft
BHST	123 degF	BHCT	107 degF	BHP	4340 psi
Starting Temp.	80 degF	Time to Temp.	00:37 hr:mn	Heating Rate	(degF/min)
Starting Pressure	510 psi	Time to Pressure	00:37 hr:mn	Schedule	9.6-1

### Composition

Slurry Density	15.82 lb/gal	Yield	1.12 ft <sup>3</sup> /sk	Mix Fluid	3.516 gal/sk
Solid Vol. Fraction	58.0 %	Porosity	42.0 %	Slurry type	Conventional

### Blend ADM EverCRET

Code	Mass Per Sack
EverCRETE	100 lb/sk

Code	Concentration	Sack Reference	Component	Blend Density	Lot Number
ADM EverCRET		100 lb of BLEND	Blend	157.63 lb/ft <sup>3</sup>	
Fresh water	2.946 gal/sk		Base Fluid		
D174	10.000 %BWOC		Expanding ce		TU0J0241A0
D206	0.050 gal/sk		Antifoam		S0818101
D145A	0.100 gal/sk		Dispersant		09402023
D500	0.400 gal/sk		GASBLOK LT		CY10220316
D177	0.020 gal/sk		Retarder		2009248AP

### Rheology (Average readings)

(rpm)	(deg)	(deg)
300	128.5	115.0
200	102.5	95.0
100	73.0	73.0
60	61.0	64.0
30	51.0	56.0
6	37.0	40.0
3	31.0	32.0

10 sec Gel		27
10 min Gel		33

Temperature	80 degF	107 degF
-------------	---------	----------

Pv: 193.092 cP	Pv: 144.553 cP
Tv: 44.84 lb/100ft <sup>2</sup>	Tv: 52.63 lb/100ft <sup>2</sup>

### Thickening Time

Consistency	Time
100 Bc	07:53 hr:mn
70 Bc	07:05 hr:mn
50 Bc	05:36 hr:mn

Remark : Thickening time do not include 2 hour batch time

### Free Fluid

0.0 mL/250mL	in 2 hrs
At 107 degF and 0 deg incl.	
Sedimentation	None

### Fluid Loss

API Fluid Loss	28 mL
14 mL in 30 min at 107 degF and 1000 psi	

### UCA Compressive Strength

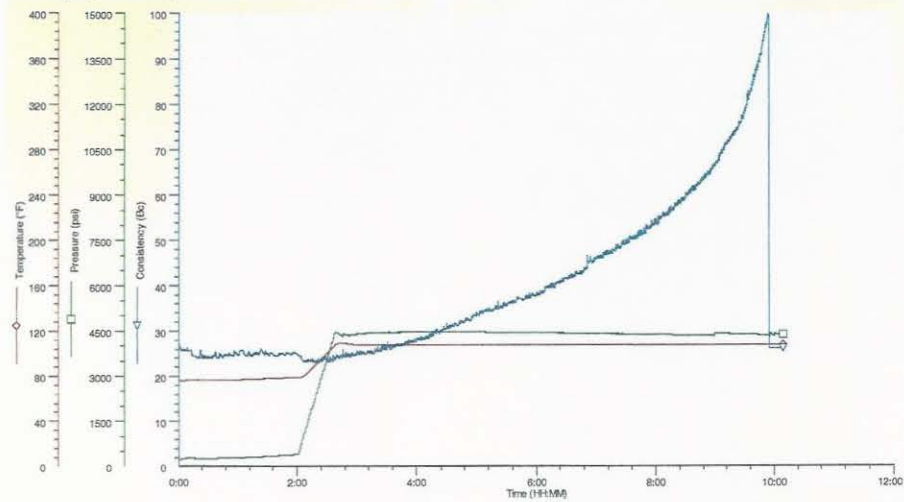
Time	CS
15:04 hr:mn	50 psi
15:35 hr:mn	100 psi
18:37 hr:mn	500 psi
24:00 hr:mn	1463 psi
72:00 hr:mn	4607 psi
105:00 hr:mn	5223 psi

Client :  
Formation :  
Country :

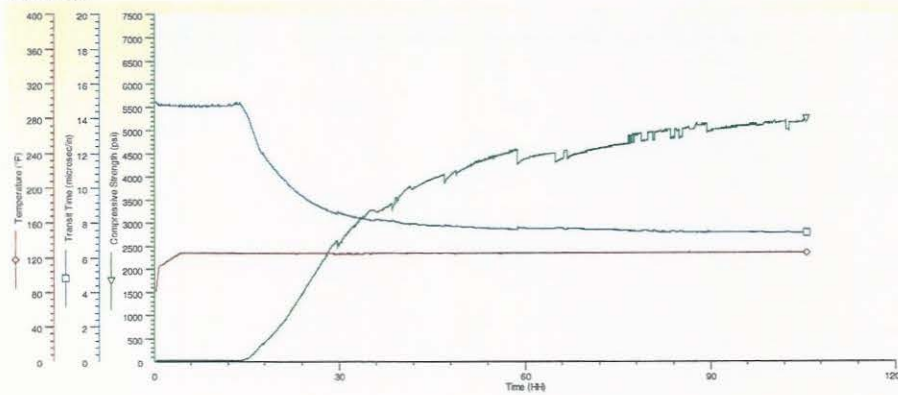
Well :  
District :

Schlumberger

Thickening Time Graph



UCA Graph



### 3. Cement

The CO<sub>2</sub> resistant cement that will be used for the injection interval has been engineered to be more resistant to degradation by wet CO<sub>2</sub> and carbonic acid than traditional Portland cement-based well cement. The primary improvement in the CO<sub>2</sub> resistant cement over traditional Portland cement is the reduction in volume of the lime and water in the set cement. The increased compatibility of the CO<sub>2</sub> and the CO<sub>2</sub> resistant cement compared to CO<sub>2</sub> and Portland cement is described below:

- The CO<sub>2</sub> resistant cement has very low Portland cement content in the set cement volume. Portland cement is the main component that goes through the carbonation process. By reducing its content, the durability of CO<sub>2</sub> resistant cement is significantly enhanced. Despite a low Portland cement content, high compressive strength is achieved (above 2,000 psi) over a wide density range (12.5 ppg -16 ppg). Even though this system has a small amount of Portland cement, it does go through the carbonation process, but it is self-limiting and prevents further leaching.
- The CO<sub>2</sub> cement system is designed with an optimized particle size distribution (PSD). Consequently, the CO<sub>2</sub> resistant cement has very high solids content, i.e. water content is reduced significantly, compared to a conventional cement system. Low water content significantly reduces the permeability of the set cement matrix and strongly reduces the cement degradation rate due to CO<sub>2</sub> reaction.
- The CO resistant cement is a lime (Ca(OH)<sub>2</sub>) “free” system compared to conventional Portland cement; for example, a neat 15.8 ppg set cement has about 13% “free” lime content. The reaction between CO<sub>2</sub> and cement is primarily due to the presence of free lime. The rate of the reaction and the amount of calcite formed from the reaction is dependent on the amount of free lime present. This reaction creates porosity in the cement. Eventually, the CO<sub>2</sub> and water mix to form carbonic acid which will dissolve the calcite, which further increases the porosity of the cement.
- The dissolution of calcite degrades the mechanical properties of the Portland cement. For longer CO<sub>2</sub> exposure, Portland cement integrity is reduced by the dissolution of calcite under acidic conditions. By having a lime-free cement system, the resistance of the cement to degradation in a CO<sub>2</sub> environment is effectively increased compared to a conventional Portland cement system.

# **Appendix D**

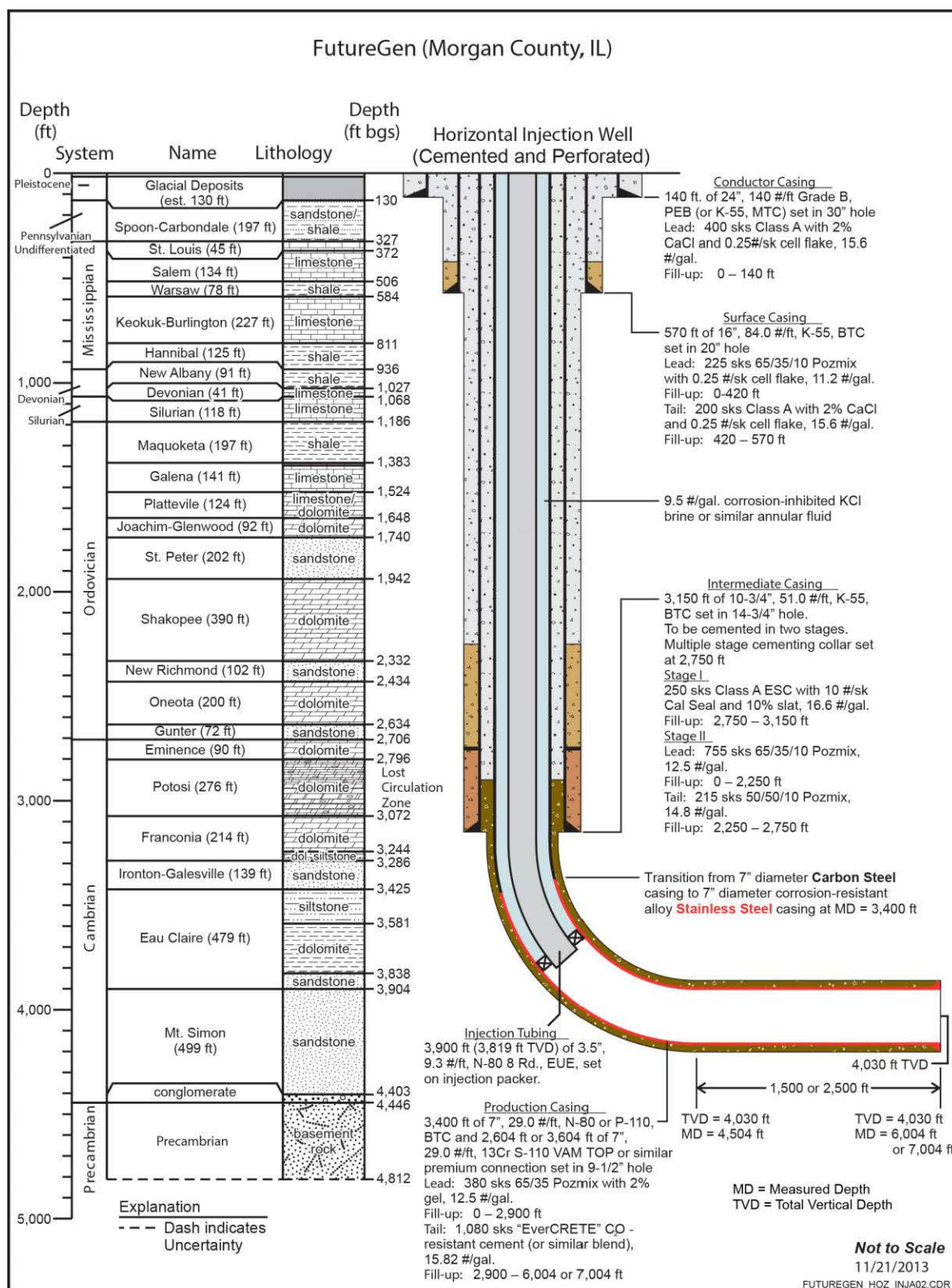
## **RAI# 10-31-2013\_009**

**Figures 4.4, 4.5, 6.1, and 6.2**

**of**

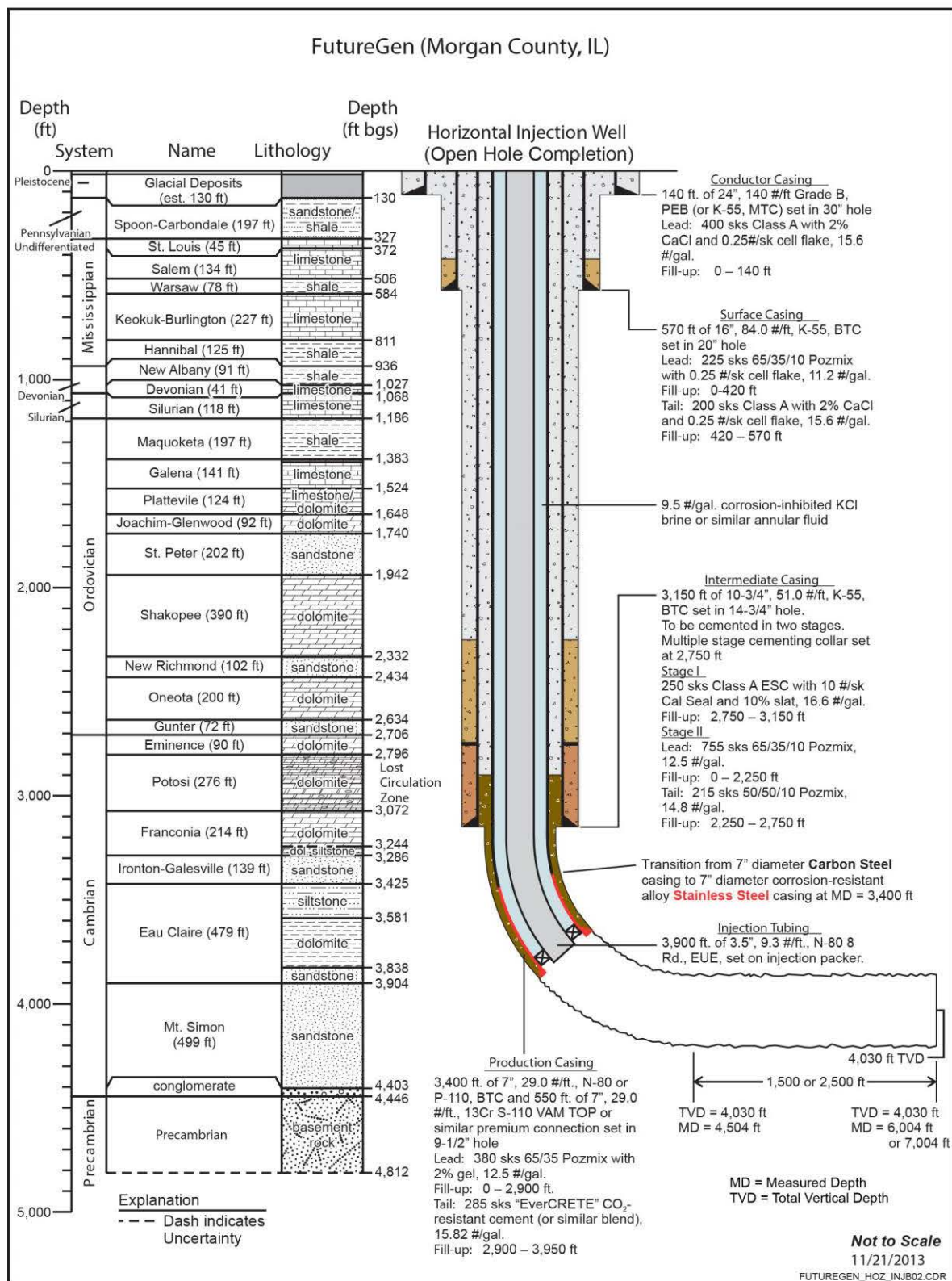
**UIC Permit Supporting Documentation**





**Figure 4.4** Injection Well Schematic – Cased-Hole Completion (geology and depths shown in this diagram are based on site-specific characterization data obtained from the FutureGen 2.0 stratigraphic well)





**Figure 4.5** Injection Well Schematic – Open-Hole Completion (geology and depths shown in this diagram are based on site-specific characterization data obtained from the FutureGen 2.0 stratigraphic well)

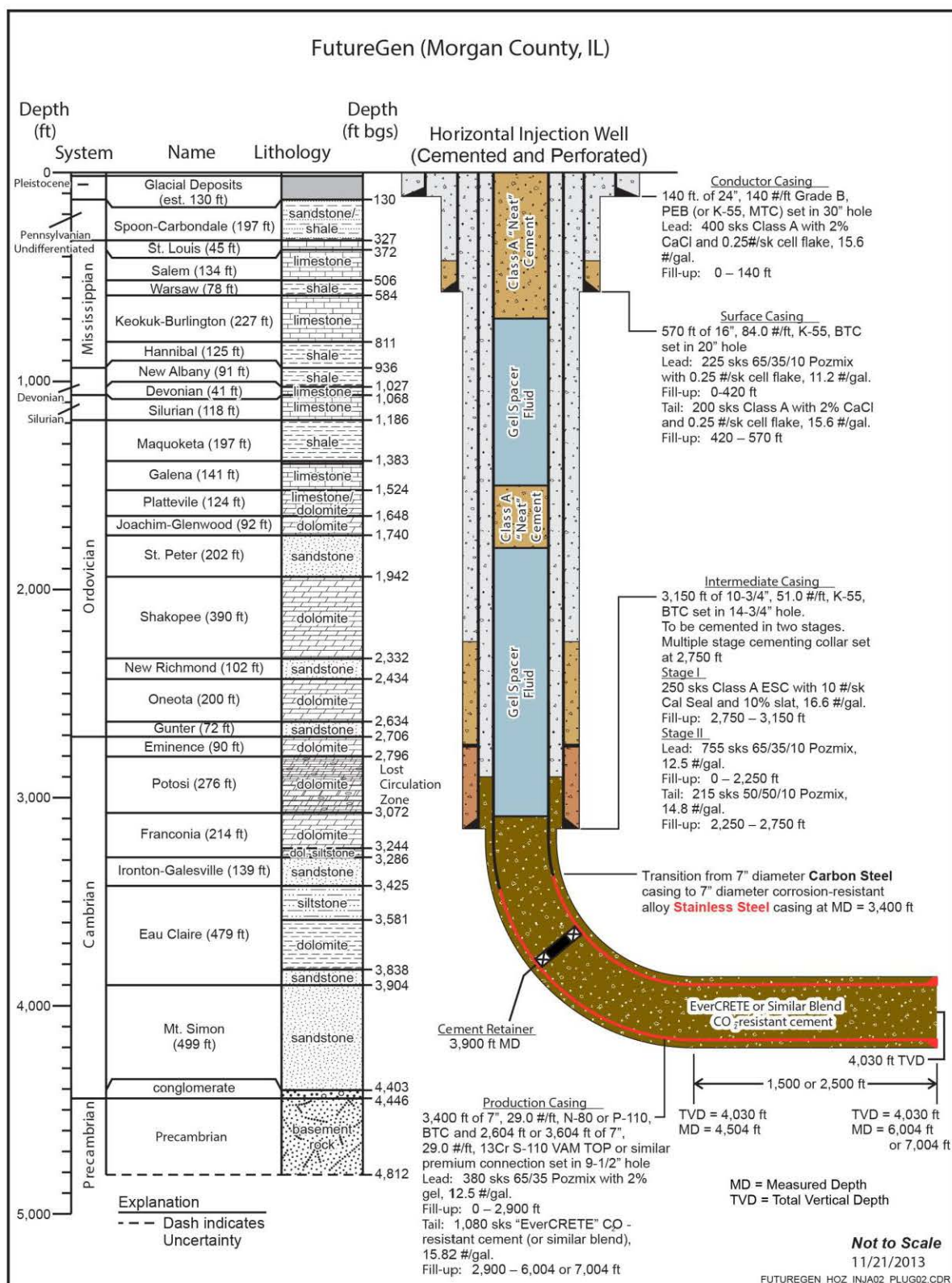


Figure 6.1. Diagram of Cased Injection Well After Plugging and Abandonment



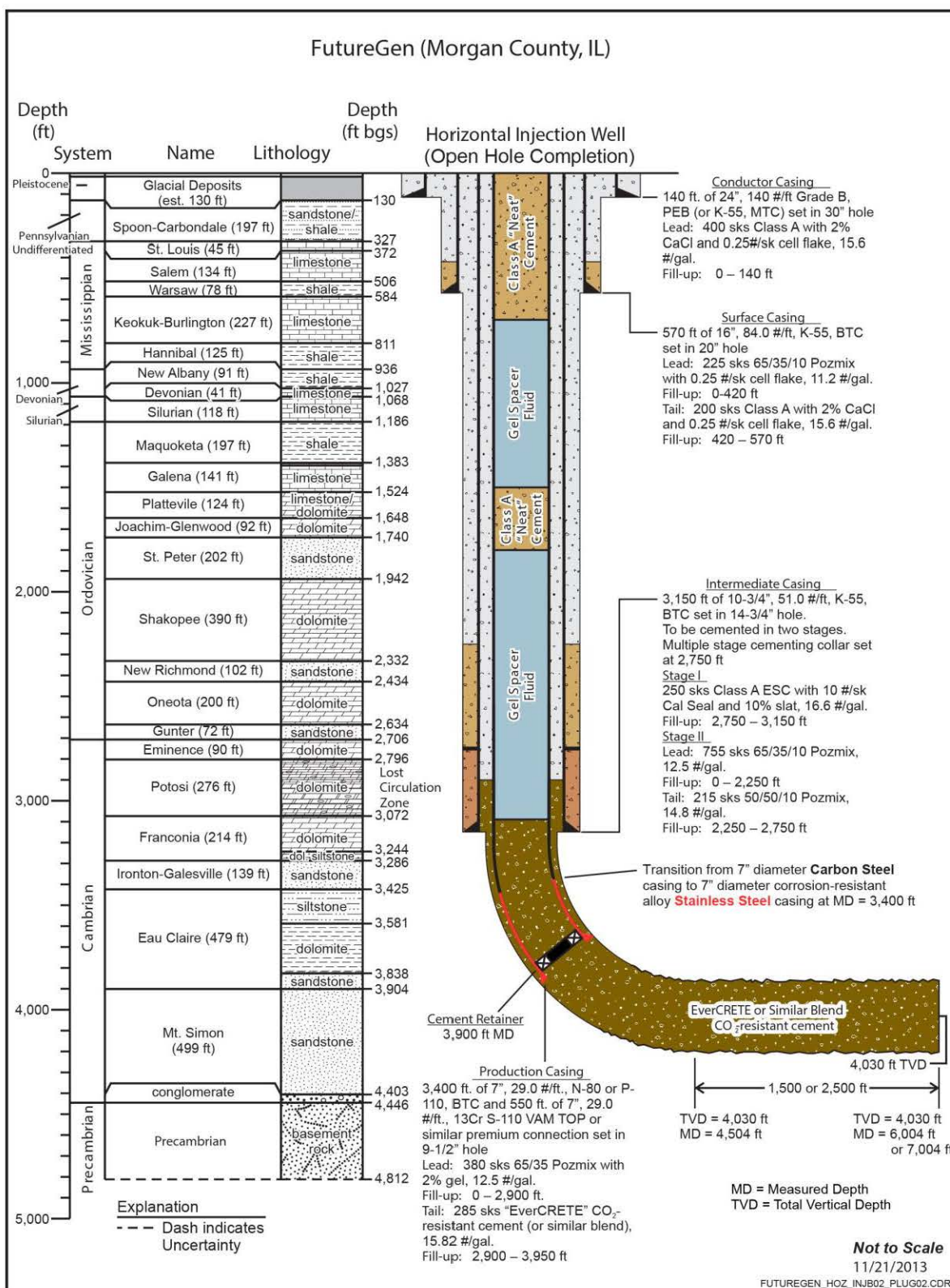


Figure 6.2. Diagram of Non-Cased Injection Well After Plugging and Abandonment

# Appendix E

## RAI# 10-31-2013\_011

Endangered Species Act Information From USFWS





## United States Department of the Interior

### U.S. FISH AND WILDLIFE SERVICE

Marion Illinois Sub-Office (ES)

8588 Route 148

Marion, Illinois 62959

(618) 997-3344



November 8, 2013

Mr. Cliff Whyte  
U.S. Department of Energy  
National Energy Technology Laboratory  
3610 Collins Ferry Road, P.O. Box 880  
Morgantown, WV 26507

Dear Mr. Whyte:

Thank you for your October 28, 2013, letter requesting concurrence on the proposed FutureGen 2.0 Project. The proposed project would be located in Morgan County, Illinois, and involves the construction and operation of a 168-megawatt gross output coal-fueled electric generation plant using advanced oxy-combustion technology and construction of a new underground pipeline approximately 30 miles long and 12 inches in diameter to transport captured CO<sub>2</sub> from the generation plant to a geologic storage area in eastern Morgan County, approximately 4,000 feet below the ground surface. These comments are provided under the authority of and in accordance with the provisions of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.); Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); and, the National Environmental Policy Act (83 Stat. 852, as amended P.L. 91-190, 42 U.S.C. 4321 et seq.).

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the Fish and Wildlife Service (Service) information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action. The list for the proposed project area includes the endangered Indiana bat (*Myotis sodalis*), threatened decurrent false aster (*Boltonia decurrens*), threatened eastern prairie fringed orchid (*Platanthera leucophaea*), and **northern long-eared bat (*Myotis septentrionalis*, proposed as endangered)**. There is no designated critical habitat in the project area at this time.

Information in the October 2013 Biological Assessment (BA) indicates that the eastern prairie fringed orchid was not observed during surveys conducted in 2012 and 2013 and suitable habitat for the eastern prairie fringed orchid does not exist with the project area, thus DOE has determined the proposed project would have no effect on the eastern prairie fringed orchid. This precludes the need for further action on this project as required under Section 7 of the Endangered Species Act of 1973, as amended for the eastern prairie fringed orchid.

Information provided in the BA indicates that proposed project will impact approximately 15.2 acres of potential Indiana bat habitat. In order to minimize and avoid impacts, wooded areas

Mr. Cliff Whyte

2

collocated with streams and wetlands would be bored under and any necessary tree clearing would occur during the winter months when Indiana bats would not be present. Based on this information and information provided in the Indiana bat habitat assessment datasheets the Service concurs that the proposed project is not likely to adversely affect the Indiana bat. According to the BA, the decurrent false aster was not observed during multiple vegetation surveys completed in 2011 and 2012 and additional surveys will be conducted in appropriate habitats prior to construction, because decurrent false aster can remain viable in the seed bank. Based on this information the Service concurs the proposed project is not likely to adversely affect the decurrent false aster. Should this project be modified or new information indicate listed or proposed species may be affected, consultation or additional coordination with this office, as appropriate, should be initiated.

The northern long-eared bat was proposed as endangered on October 2, 2013 and thus was not considered in the BA. A final decision on listing the species will be made prior to the proposed construction start date; therefore, we are providing additional information regarding this species. The northern long-eared bat hibernates in caves and roosts and forages in upland forests and woods. Potential habitat for this species occurs statewide, therefore, they are considered to potentially occur in any area with forested habitat. Minimization and avoidance measures for the northern long-eared bat are similar to the Indiana bat; therefore, the Service concurs that with implementation of the proposed minimization and avoidance measures for the Indiana bat the proposed project is not likely to adversely affect the northern long-eared bat.

Although the bald eagle has been removed from the threatened and endangered species list, it continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA). The Service developed the National Bald Eagle Management Guidelines to provide landowners, land managers, and others with information and recommendations regarding how to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is prohibited by the BGEPA. The Service is unaware of any bald eagle nests in the proposed project area and none were found during a survey of the project area. If a bald eagle nest is found in the project area or vicinity of the project area in the future then our office should be contacted and the guidelines implemented. A copy of the guidelines is available at:

<http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BaldEagle/NationalBaldEagleManagementGuidelines.pdf>

Thank you for the opportunity to provide information concerning threatened and endangered species. For additional coordination, please contact me at (618) 997-3344, ext. 345.

Sincerely,



Matthew T. Mangan  
Biologist in Charge